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Social cognition in anorexia nervosa: Specific difficulties in decoding emotional but not non-emotional mental states

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RUNNING HEAD: SOCIAL COGNITION IN ANOREXIA NERVOSA

Abstract

Objective: Building on recent models of anorexia nervosa (AN) that emphasize the importance of impaired social cognition in the development and maintenance of the disorder, the present study aimed at examining whether women with AN have more difficulties with inferring other people's emotional and non-emotional mental states than healthy women.

Method: Social cognition was assessed in 25 adult women with AN and 25 age-matched healthy women. To overcome limitations of previous research on social cognition in AN, the processing of social information was examined in a more complex and ecologically valid manner. The Movie for the Assessment of Social Cognition (MASC) reflects complex real-life social interaction and allows for disentangling emotional and non-emotional mental state inference as well as different types of errors in mentalizing.

Results: Women with AN showed poorer emotional mental state inference, whereas non-emotional mental state inference was largely intact. Groups did not differ in undermentalizing (overly simplistic theory of mind) and overmentalizing (overly complex or over-interpretative mental state reasoning). Performance in the MASC was independent of levels of eating disorder psychopathology and symptoms of depression and anxiety.

Discussion: The findings suggest that AN is associated with specific difficulties in emotional mental state inference despite largely intact non-emotional mental state inference. Upon replication in larger samples, these findings advocate a stronger emphasis on socio-emotional processing in AN treatment.

Keywords: Theory of Mind, Empathy, Mentalization, Socio-emotional processing, Mindreading, Eating Disorders

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You can only understand people if you feel them in yourself. (John Steinbeck, 1952, p. 448)

Introduction

Recent models of anorexia nervosa (AN) emphasize the role of impaired social cognition in the development and maintenance of the disorder (1, 2). According to these models, self-starvation and purging behavior may serve as maladaptive maneuvers to cope with impaired social cognition and to reduce social threat. The concept of social cognition (often also referred to as theory of mind, mindreading, or mentalizing) refers to mental processes that underlie social interaction and involve several skills that allow an individual to 'put oneself into another's shoes' such as (a) building mental representations of interpersonal relationships, (b) inferring others' thoughts, emotions, and intentions and (c) utilizing this information to shape their own social behavior (3). Furthermore, a distinction can also be drawn between the inference of emotional versus non-emotional mental states, and between the decoding of distinct behavioral cues (e.g. facial or vocal emotional expression) and the decoding of more ambiguous and complex stimuli under consideration of the wider context of a social situation (i.e. higher-level inferences) (4).

Building on the partial phenomenological overlap between AN and autism spectrum disorders (where impaired social cognition constitutes a hallmark feature) (5, 6), several studies have examined social cognition in AN. These studies have shown a reduced ability to infer others' emotions and cognitions from their faces and voices (7-9) with tentative evidence suggesting that the inference of emotions may be more affected than the inference of cognitions (10, 11). Two meta-analyses confirmed the presence of impaired recognition of (particularly complex as opposed to basic) emotions in others and in higher-level mental state inference (4, 12) in AN. It appears likely that these

difficulties in socio-emotional processing contribute to impaired social skills and competences associated with social withdrawal and social impoverishment in people with AN (13, 14).

Impaired social cognition has been assumed to be both a precursor and a maintenance factor in AN (1, 2). Evidence that aberrant social cognition could represent a stable trait rather than just a secondary consequence of starvation (1, 2) involves findings of poorer emotion recognition in monozygotic as compared to dizygotic twins of individuals with eating disorders (15), poorer social cognition in children at high risk for eating disorders (due to maternal eating disorder exposure) (16), and sustained difficulties in emotion recognition in women recovered from AN (17, 18). However, once malnutrition and concomitant underweight have reached a certain level this may further exacerbate the pre-existing difficulties in socio-emotional processing. Food restriction has been assumed to reduce emotional perception and to alter emotional processing in AN (19, 20). This potential mechanism may provide patients with AN with a temporary respite from aversive feelings (20-22). In line with this notion, a lower body weight was found to be related with lesser difficulties in emotion regulation and less retrieval of negative emotions in autobiographic memories in women with AN (23, 24). Importantly, this could constitute a vicious cycle of negative reinforcement contributing to the maintenance of the disorder (1). In fact, impaired social cognition was found to have a detrimental impact on prognosis and treatment outcomes (6, 25).

However, a limitation of previous research on social cognition in AN is the confounding of emotional and non-emotional sub-components as most studies have used tasks that do not allow for a clear distinction between these (4, 12). Considering only studies that used more clear-cut measures of either emotion recognition or cognitive theory of mind, there is cumulative evidence for both impaired recognition of (particularly complex) emotions in others' faces and voices (8, 11, 18) and impaired representation and attribution of non-emotional states in AN (9, 26) (for systematic reviews see (4, 12)). The interpretation of previous studies focusing exclusively on non-emotional mental state inference is, however, complicated by the fact that the measures that have been employed in these studies are highly correlated with verbal intelligence and thus may be of limited usefulness for the

assessment of 'pure' social cognition (27). Indeed, AN studies using such tasks found no selective impairment of social cognition as patients also showed poorer performance in control items of these tasks which suggests that low theory of mind in AN was confounded by impaired attention and working memory in these studies (9, 26). Hence, there appears to be more conclusive and robust evidence for impaired emotional theory of mind than for cognitive theory of mind in AN.

However, this evidence is almost completely based on studies that used tasks of limited ecological validity as they barely satisfy complex real-life situations in the daily lives of adults (e.g. the *Reading the Mind in the Eyes Test* (28)). These tasks either assess the ability to recognize emotions in others' faces or voices in an isolated fashion (7, 9, 10, 16, 17) or are based on stories or comics that are pitched to the level of normal 8-9 year old children and may thus not be best suited for assessing subtle mindreading deficits in adults with normal intelligence levels (9, 26). So far, only two studies have compared patients with AN and healthy people by means of tasks that measure mental state inference based on complex real-life social interaction (18, 29). These two studies did not find social cognition deficits in patients with AN, except for a reduced perception of levels of intimacy. However, similar to less ecologically valid tasks, the measures used in these two studies do not allow for a differentiation between emotional and non-emotional mental state inference, and one of the tasks is furthermore limited to the perception of very specific social phenomena like intimacy, kinship, or competition and thus probably to narrowed to detect broader deficits in social cognition (29). In addition, the same study involved not only patients with full-syndrome AN but also those with sub-threshold forms of the disorder and may thus have been confounded by levels of eating disorder symptom severity.

The present study aimed to overcome some of these limitations of previous studies by using an ecologically valid task for the multidimensional assessment of higher-level inference of other people's emotional and non-emotional mental states in complex real-life interactions. A further advance of this methodological approach is that it allows for the differentiation between different types of errors in mental state inference, i.e. undermentalizing and overmentalizing. Whereas the former refers to overly simplistic or even completely lacking mental state inference, the latter refers to overly complex,

over-interpretative mental state reasoning (i.e. an excessive attribution of mainly malevolent intentions to others) (30). Examining different kinds of errors in mental state inference could shed new light on the exact nature of social cognition in AN. Previous research has demonstrated, for example, that patients with borderline personality disorder feature a tendency to overmentalize whereas patients with schizophrenia are rather characterized by undermentalizing (30).

Based on the theoretical models and empirical findings outlined above, we hypothesized that women with AN will show poorer mental state inference than healthy women, particularly in terms of emotional mental states. In an exploratory fashion, we also examined whether potential difficulties in social cognition in AN are driven by under- or overmentalizing.

Methods and Materials

Participants

Women with AN were recruited from a specialized inpatient unit and outpatient center for eating disorders of a university hospital in Germany. Diagnostic assessment was based on the *Structured Clinical Interview for DSM-IV Axis I and II disorders* (31). Participants in the AN group had to meet the criteria for a principal DSM-IV diagnosis of AN. Exclusion criteria for the AN group were: current suicidal intentions or an acutely life-threatening condition, current or past substance use disorder, organic mental disorder, schizophrenia, bipolar disorder, or borderline personality disorder, and current major depressive disorder. Exclusion criteria for the healthy control group were any lifetime diagnosis of a DSM-IV mental disorder or a current Body Mass Index (BMI) below 18.5 kg/m^2. Participants provided written informed consent and received financial compensation for their participation in the study. The institutional ethics committee approved the procedure.

An a priori power analysis was conducted based on the pooled effect sizes for differences between healthy individuals and those with AN in complex emotion recognition (d = 1.01) (4) and higher-level mental state inference (d = 1.07) (12). The power calculation revealed that a sample size of 17 participants per group would have 80% power to detect the smaller of the two above mentioned effect

sizes (*d* = 1.01) using an independent samples *t*-test with a 0.05 two-tailed significance level. In order to compensate for any potential loss of data, e.g. due to technical errors, we applied a more conservative scheme and increased the sample size to 25 participants per group.

Measures

Eating disorder psychopathology. The *Eating Disorders Examination Questionnaire* (EDE-Q) (32) was used to assess the severity of eating disorder symptoms. The EDE-Q is a commonly used self-report measure in eating disorder research featuring good psychometric properties and it consists of 28 items that comprise four subscales assessing restraint eating, eating concern, weight concern, and shape concern over the last 28 days (32). In addition, the participants' body height and weight was objectively assessed. Participants' BMI was calculated using bodyweight in kg divided by height in m squared (kg/m^2).

Symptoms of depression and anxiety. Levels of depression and anxiety were assessed with self-report questionnaires featuring excellent validity and reliability, i.e. the *Patient Health Questionnaire-9* and the *Generalized Anxiety Disorder Screener-7* (33, 34). The items of both measures reflect the DSM-IV criteria of major depressive disorder and generalized anxiety disorder, respectively. Participants were asked to rate how often they have suffered from each of the symptoms during the previous two weeks.

Social Cognition. To assess individual differences in social cognition we used the (original German) multiple choice version of the *Movie for the Assessment of Social Cognition* (MASC) (27). The MASC is a video-based test that was developed for an ecologically valid assessment of subtle mindreading difficulties in adults. It adopts traditional social cognition concepts such as first- and second-order false belief, faux pas, metaphor, and sarcasm in a multimodal way (i.e. using visual and auditory cues) and operationalizes these concepts through a short movie that was designed to approximate real-life social interactions. Participants are shown a 15 min film clip about two women and two men getting together for a dinner party. The characters in the movie share different levels of intimacy with each

other and feature distinct trait characteristics such as outgoing, timid, or selfish, and experience different emotions during the course of the evening such as anger, affection, or embarrassment. Participants are given the instruction that they should try to understand the mental states (i.e. feelings, thoughts, and intentions) of the characters and to answer 45 multiple choice questions at given breaks (e.g. 'What is Betty feeling?', 'What is Cliff thinking?'; for an example see Figure 1). In order to do so, participants have to take into account both verbal and non-verbal expressions of thoughts and emotions. Verbal expressions vary on whether they are to be taken literally or not, and non-verbal cues range from facial expression to body language and gestures. The multiple choice version of the MASC allows for the analysis of two mental state modalities, i.e. non-emotional/cognitive ('What is X thinking/intending?') and emotional mental state decoding ('What is X feeling?'), as well as two error categories: 'undermentalizing' reflecting insufficient mental state reasoning, and 'overmentalizing' reflecting over-interpretative mental state reasoning. In the present study, we used a computerized, fully automated version of the MASC that was presented on a laptop and run using OpenSesame experimental software (35). In previous studies, the MASC has been shown to be a reliable and highly sensitive measure for the assessment of mindreading abilities (27). It was even superior to standard social cognition tasks such as the *Reading the Mind in the Eyes Test* (28) in detecting theory of mind deficits in patients diagnosed with Asperger syndrome and schizophrenia (27). The MASC also allows for the reliable detection of subtle mindreading difficulties in healthy individuals of normal IQ (36).

Results

Sample characteristics

Demographic and clinical characteristics of the sample are displayed in Table 1. Only women participated in the study. Groups did not differ in terms of age and educational level. All but one patient had the restricting subtype of AN. Most patients were currently receiving inpatient treatment, and four were taking also psychotropic medication. The BMI of patients ranged between 12.90 and

17.30 kg/m^2, and duration of illness ranged between 0.5 and 26 years. Approximately one quarter of the patients had a co-morbid anxiety or obsessive-compulsive disorder. Per definition, patients with AN had a lower BMI and reported higher levels of eating disorder symptoms than participants in the control group. As to be expected, patients with AN also reported more symptoms of depression and anxiety than participants in the control group.

Group differences in social cognition

Results from the MASC are displayed in Table 2. Inspection of histograms and boxplots and a Shapiro-Wilk Test confirmed that MASC data were normally distributed. No extreme outliers with scores exceeding 3 *SD* could be detected. Groups did not differ in terms of non-emotional mental state inference. However, patients with AN had more difficulties with emotional mental state inference than healthy participants. The exploratory analysis of error responses revealed no group differences in undermentalizing or overmentalizing.

Associations between social cognition and psychopathology

Performance in decoding emotional and non-emotional mental states as well as undermentalizing and overmentalizing were unrelated to BMI, EDE-Q total score, PHQ-9, GAD-7 scores, and duration of illness (all *p*s > .183).

Discussion

The present study examined social cognition in healthy women and those with AN. In support of our main hypothesis, we found that patients with AN had more difficulties in decoding emotional mental states than their healthy counterparts. However, the inference of non-emotional mental states seemed largely intact in women with AN. This finding is in line with previous findings of impaired

recognition of other peoples' emotions in AN (4, 12) as well as with tentative evidence that emotional theory of mind may be more impaired than cognitive theory of mind in AN (10, 11).

Importantly, the present study overcomes several limitations of previous research on social cognition in AN by using a measure of social cognition that has (a) high ecological validity due to the utilization of a movie that depicts complex real-life social interaction, (b) allows for disentangling between emotional and non-emotional mental state inference, and (c) that is unrelated to levels of verbal intelligence (27). In addition, the present study has also overcome some of the sample-related limitations of previous studies on social cognition in AN. Potentially confounding effects of co-morbid disorders and largely varying eating disorder symptom severity could be ruled out by an a priori exclusion of patients with comorbid major depressive disorder or borderline personality disorder, and those with sub-threshold AN. Previous studies on social cognition in AN did not control for these potentially confounding effects despite strong evidence that major depressive disorder and borderline personality disorder are associated with social cognition impairments on their own respect (37-40). In addition, potentially confounding effects of sub-threshold symptoms of depression and anxiety could be ruled out by demonstrating that these were unrelated to the performance in the social cognition task which is also in line with a previous study in AN (4).

These methodological advantages have helped to reveal an important difference in the processing of complex emotional versus non-emotional social information in AN. In contrast to previous assumptions, the findings of the present study suggest that non-emotional social cognition is largely intact in AN when considering complex real-life interaction. The confounding of emotional and non-emotional information processing in the tasks that had been employed in previous studies on social cognition in AN together with their lack of ecological validity may have obscured this important distinction. However, it remains to be seen whether this finding can be replicated with similar tasks in larger samples.

The present study has also demonstrated that social cognition in AN is not characterized by under- or overmentalization, two specific kinds of errors in mental state inference with the former being

typically associated with schizophrenia and the latter with borderline personality disorder (30). Subject to replication, this finding suggests that social cognition in AN is not biased by heightened distrust (overmentalizing) or a systematic underestimation of other people's mental states (undermentalizing) but rather by more subtle difficulties in correctly decoding other people's emotional mental states.

In line with most previous research on social cognition in AN, the lack of a significant relationship between performance in the social cognition task and levels of eating disorder psychopathology including BMI in the present study suggests that poor social cognition is not merely attributable to (the level of) dietary restraint and starvation (7, 9, 10, 18).

Implications for future research

Against the backdrop of neurobiological models of socio-emotional processing in AN, the reduced ability to decode specifically emotional mental states in AN may be attributable to altered brain serotonin activity (20) and regional alterations in brain volume (i.e. reduced grey matter volume), particularly in the anterior cingulate cortex and amygdala that play crucial roles in emotion recognition and regulation (41). In line with this assumption, previous research has shown that performance in the MASC is positively related to amygdala volumes in healthy adults (42). Given these findings, it seems promising to combine the use of social cognition paradigms with the application of neuroimaging to gain further insight into the exact nature and neural underpinnings of social cognition in AN. Another promising and clinically relevant avenue for future research in this domain refers to the differentiation between distinct clusters of patients with AN with specific neuro-cognitive and socio-emotional profiles that are irrespective of levels of psychopathology (43, 44). This could help to tailor interventions more specifically to the needs of patients. Another future prospect in this domain could be a stronger involvement of the patient in the experimental paradigms. Whereas almost all previous studies in the field relied on paradigms in which the participant acts as an observer of other (more or less) interacting people, it appears also promising to examine social interaction more directly

in the patients themselves (i.e. the interaction of the patient with others). For instance, a recent study showed that patients with AN perceive more coldness in mock feedback from job supervisors and tended to also respond with more coldness (45).

Limitations

Several limitations of the present study need to be considered. Although an a priori power calculation was conducted to determine a sufficient sample size for testing the hypothesis, the sample size is still small and thus, the findings should be regarded as rather preliminary until replicated with similar measures in larger samples. Such studies should also include a sufficient number of patients with either the restricting or the binge-purge subtype of AN to find out whether and to what degree these subtypes differ in social cognition. Additionally, most patients in the present study were in psychotherapeutic treatment and some were also medicated. Theoretically, this could have influenced the results to some degree. However, one would then expect even larger deficits in social cognition in untreated patients. It should be mentioned in this context, that re-running the analysis with those patients excluded who (a) were not in psychotherapeutic treatment or (b) were on psychotropic medication, yielded lower effect sizes but the same pattern of results. Furthermore, the cross-sectional design of the present study precludes any causal interpretations regarding the relationship between poor social cognition and AN psychopathology. Prospective, longitudinal studies in large cohort studies would allow for a deeper understanding of whether and how difficulties in social cognition contribute to the development and maintenance of the disorder. In addition, the movie is set in a dinner party scenario which could have unsettled and distracted the patients to some degree. However, the movie is comprised of several scenes (e.g. two characters meeting and making a date; each of them persuading another person via phone to join the gathering; the successive arrival of the four people at the party; several conversations in the living room; people playing a table game) and only in one scene people are shown how they prepare food and have dinner during their conversations but still the food is barely visible as the camera focuses on the characters' faces.

Nevertheless, future studies on social cognition in eating disorders should ideally use stimuli that are unrelated to food and eating. Finally, it remains unclear whether the findings are restricted to impairments of complex, higher-level social information processing, as we have not included more basic tasks on social cognition.

Clinical implications

The findings of the present study argue for a stronger emphasis on socio-emotional processing in the treatment of AN. Most psychotherapeutic treatment approaches such as Focal Psychodynamic Therapy, Cognitive-Behavioral Therapy and the Maudsley Model of Anorexia Nervosa Treatment for Adults address social cognition to varying extents and have proven some effectiveness in treating AN (46). However, information on the efficacy of these treatments to improve social cognition in AN is still lacking. A particularly severe sub-group of patients with AN are those with a comorbid borderline personality disorder which typically involves strongly impaired social cognition. For this subgroup, Mentalization Based Therapy (i.e. an evidence based treatment for borderline personality disorder) has been adapted and is subject to scientific investigation in a current randomized controlled trial (47).

Furthermore, the findings argue for the inclusion of the patients' partners and families (48) in the treatment as well as to offer formal skills training (49) to support the decoding of mental states in complex real-life social interactions. Furthermore, the development of novel treatments that more specifically target social cognition (e.g. cognitive bias modification procedures (50)) are needed. However, far more research is needed to support the utility of such treatment modules and also to determine optimal strategies of delivering and implementing these into existing treatment approaches.

Conclusion

In a nutshell, the findings of the present study suggest that adult women with AN show subtle difficulties specifically in emotional but not in non-emotional mental state inference in complex real-

life social interactions and that this effect is independent of levels of eating disorder psychopathology, depression, anxiety, and intelligence. Future research on social cognition in AN may involve neuroimaging methods and paradigms that engage the participants themselves more directly instead of putting them in an observer position. The findings argue for a stronger involvement of the social network of patients in treatment and the use of add-on treatment modules that specifically target social cognition in AN.

Table 1. Demographic and clinical characteristics of the sample

	AN (*n* = 25)	HC (*n* = 25)	Test statistic	*p*
Mean age in years (*SD*)	23.72 (5.67)	24.56 (2.26)	$t(48) = 0.69$	.494
Educational level				
% A-level [a]	87%	100%	$\chi^2(1) = 3.48$	.062
Mean BMI in kg/m^2 (*SD*)	15.30 (1.23)	21.82 (1.76)	$t(48) = 15.21$	< .001
Duration of illness in years (*SD*)	4.63 (5.39)	-	-	-
AN subtype				
% restricting	96	-	-	-
Co-morbid diagnoses (%)				
Anxiety disorder	24	-	-	-
Obsessive-compulsive disorder	8	-	-	-
Current psychotropic medication (%)	16	-	-	-
Current psychotherapeutic treatment				
% inpatient	76	-	-	-
% outpatient	0	-	-	-
Mean EDE-Q total score (*SD*) [b]	3.12 (2.37)	0.37 (0.41)[b]	$t(44) = -5.57$	< .001
Mean PHQ-9 score (*SD*) [c]	13.44 (5.93)	1.79 (1.56)	$t(45) = -9.29$	< .001
Mean GAD-7 score (*SD*) [c]	10.74 (4.31)	1.21 (1.47)	$t(45) = -10.23$	< .001

BMI = Body Mass Index; EDE-Q = Eating Disorder Examination Questionnaire; PHQ-9 = Patient Health Questionnaire-9 (Depression Module); GAD-7 = Generalized Anxiety Screener; [a] = data on educational level missing from two patients; [b] = EDE-Q data missing from three patients and one healthy control participant; [c] = PHQ-9 and GAD-7 data missing from two patients and one healthy control participant

Table 2. Group differences in the Movie for the Assessment of Social Cognition

	AN (n = 25)	HC (n = 25)	Test statistic	p	Cohen's d
	M (SD)	M (SD)			
Emotional mental states (% correct responses)	73.33 (12.32)	81.09 (12.09)	$t(48)$ = 2.25	.029	-0.64
Cognitive mental states (% correct responses)	75.61 (9.83)	79.61 (10.03)	$t(48)$ = 1.43	.160	-0.40
Overmentalizing (% correct responses)	13.53 (6.15)	10.33 (7.07)	$t(48)$ = -1.71	.094	0.48
Undermentalizing (% correct responses)	12.29 (5.26)	9.54 (6.42)	$t(48)$ = -1.66	.104	0.47

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